MACHLETT

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THE Springdale building was a long, narrow structure, at 1063 Hope Street. Now surrounded by much larger additions, it is identifiable as the three-story section next the present trailer delivery yard. Machlett Laboratories at first occupied only the two lower floors. In the top story, the existing tenant was a manufacturer of preparations high in spirituous content. It soon appeared that this firm's operations were also spirited, and that splashed alcohol was apt to come seeping through the Machlett ceilings from above, at unexpected times and places. This caused Machlett people a good deal of consternation, since one of the prime necessities of their exacting operation, drilled into everybody from the start, was meticulous cleanliness. They counted the days till the upstairs tenant's lease expired, and breathed a unanimous sigh of relief when they got the whole building to themselves.

They had set about creating an improved ray-proof tube, to be not only a high performance diagnostic unit in a ray-proof lead-Bakelite housing, but to be rugged, portable, small, light and compact, so that it could be positioned wherever professional use required. The result, brought out early in 1934, was the CYR, a tube that strikingly exemplified for the first time what has since become well known as a basic and readily recognizable characteristic of Machlett tubes: utmost compactness of exceptionally rugged parts, to take every advantage of what has been called "geometry of design." That is, (1) getting into a smaller-than usual space elements that are heavier-than-usual wherever massiveness will mean extra performance (as, in this case, a very heavy copper-backed anode). (2) Combining elements in such a way that each adds to the other, and all to the strength of the whole (as, in this case, the heavy copper anode carries the weight of the tube. In previous tubes the glass tube carried the weight of the anode. Again, the Bakelite housing is not merely a shield but a structural member, supporting the tube and so eliminating the need of end-caps on the tube.) (3) Good design geometry, too, employs to the greatest possible advantage the inherently great strength of cylindrical forms—if possible coaxial with one another.

The small, compact CYR was greeted with considerable enthusiasm in the radiographic profession, many of whose most eminent practitioners had counseled with Ray Machlett and Skehan during the course of its design and experimental construction.

The CYR was a ray-proof tube. But it was not proof against a secondary hazard in the practice of radiology—a hazard which had been growing with the increase in voltages:

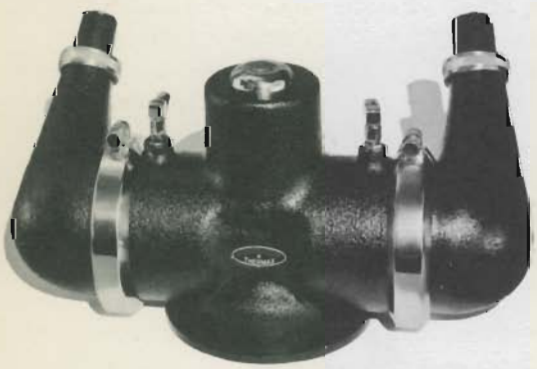
Since the earliest days of x-ray practice, the danger of shock from high voltages had been recognized as second only to that of injury from radiation. Early practitioners were accustomed to suspending their tubes from any convenient lighting or plumbing fixture—often hitching the patients to the same installations for additional safety. Later, the tube—and sometimes the transformer as well—was mounted in a grounded enclosure. Such installations were bulky indeed, and even if expensively made, with ingenious pivoting and careful counterbalancing, they could not be conveniently positioned for certain uses. To overcome such difficulties Machlett devised a relatively compact, air-insulated, shockproof shield for the CYR tube. This was a grounded metallic enclosure to which high voltage was supplied through well-insulated flexible cables. The CYR had, moreover, another feature: the tube could be readily inserted or withdrawn for replacement.



Machlett's CYR tube of 1934 was the first ray-proof x-ray tube, compact and light for easy positioning. It achieved these advantages by using what has since become widely known as "geometry of design"—a hallmark of Machlett engineering.



One of the earliest types of "shockproof" apparatus.



Machlett's Thermax tube had an oil-insulated housing which made it safely shockproof, though it was a tube of unusually high voltage for its day.

Existing shockproof units were not only too bulky for efficient positioning, but their shockproofing depended upon insulation by a filling of dielectric oil. Whenever a tube had to be replaced in such an installation, the whole business had to be shipped back to the equipment maker, or the old tube had to be taken out of its oil bath and replaced, either in the doctor's office or in the dealer's shop. This was an annoying interruption at best, and likely to be a messy one as well.

The shockproof CYR achieved so promising a degree of success that Machlett followed it immediately with a substantially similar tube in an oil insulated housing, for considerably higher voltages—the Thermax. This, too, succeeded so well that they set about designing a tube which should combine the advanced features of both the CYR and the Thermax.

They saw a great place for a tube that would be in itself a complete rayproof, shockproof, quickly installable-and-removable unit, oil insulated within its own housing. One that would be, moreover, so light and compact that, with flexible shockproof cables designed to go with it, it could readily be positioned for all common diagnostic applications.

It was not easy to design a tube of these characteristics. There were those, indeed, who said it could not be done. The illustrious Coolidge himself was reported to be skeptical whether Machlett's people could successfully achieve so much in so small a space.

There were, as well, practical problems in manufacture, to make a theoretically superior tube actually superior in use and in life. These included not only problems to which Machlett was accustomed in the making of high-vacuum, high-voltage tubes, but additional ones such as the treatment of oil to avoid possibility of its insulating properties being broken down by exposure to air during assembly or by deterioration under the effects of heat and electrical stress while in use.

Solution of these problems involved among other steps: treatment of the copper anode chemically to retard its catalytic effect on hot oil; filling the shockproof enclosures under vacuum; and immediate hermetic sealing. The whole amounted to a process that was Machlett's own by virtue of discovery.

The new CYS tube—half the size of the tube-and-housing heads in previous shockproof equipment—Went to Town. There is no other phrase to describe its reception by the radiological profession. It not only met existing needs in a way that no tube had up to that time, but it opened up whole new areas in diagnostic radiology by making possible new applications, new techniques. For example, the taking of a stereoscopic pair of negatives, hitherto exceedingly difficult, was simple with this small, movable, rayproof and shockproof tube.

In bringing out the CYS Machlett added another advantage, almost as attractive to the professional user as any inherent feature of the tube itself: They sold the unit as a whole, but under an agreement that it could be returned as a whole when the insert tube was finally used up in service, for essentially full credit on the housing. So, in effect, the x-ray user paid only for the insert tube. (The housing would normally be in perfectly good condition for refinishing and use with another unit.) This practice is now standard in the x-ray tube business, but at the time Machlett introduced it, it was an innovation almost as startling as the tube itself.

Among them, all these compact tubes opened further what had been only a very small chink into a big potential field for x-ray use. A few industrial firms were already using radiography for non-destructive testing of fabricated parts or assemblies. But their number was limited to those



The CYS tube was an innovation in design —half the size of previous ray- and shock-proof tubes. It had the added advantage that the insert could be readily changed.

that could bring pieces for testing to a fixed x-ray installation. The portable tube could be brought to work in process and used on several parts of it in quick succession. Thus Machlett entered a field where great numbers of its tubes are now in daily use.

The number of such uses, both medical and industrial, was again greatly increased by a tube Machlett brought out in 1939—the Aeromax, for radiography, fluoroscopy and therapy. In essence this was the CYS in a housing with integral forced-air cooling. It was the first air-cooled, oil immersed, shockproof tube unit of modern small size and light weight designed for continuous operation.

In developing these tubes and others, both x-ray and valve, which accompanied them, Machlett had necessarily to master increasingly difficult techniques. By the time of the CYS, for example, voltages up to 100,000V were accepted as common in diagnostic radiology. Heavy currents at high voltage in a high vacuum produce effects that impose problems of extraordinary difficulty in manufacture.

Few laymen realize, for example, that glass is actually a fluid substance. It contains absorbed gases, and in a vacuum at high heat, it gives up those gases somewhat the way a warm bottle of soda water fizzes when the cap is removed—though of course so minutely that only very sensitive instruments can detect this "out-gassing." But even the minutest quantities of gas can impair the quality of vacuum needed for a high voltage tube. Metals, too, give up gases under heat and vacuum, especially if there are impurities in them. And the least amount of oil or grease on either glass or metal—as from the lightest touch of a fingertip—can completely ruin the quality of a vacuum. These and scores of other things that can happen inside a hot, highly charged vacuum, called for a new order of purity in materials, of faultlessness in cleaning, of thoroughness in pumping, of strength and flawlessness in sealing, of care in testing.

It was during this period that Machlett worked out many of the techniques and procedures that are now fundamental and distinctive in its making of big, high voltage and high power electron tubes: the vacuum casting of copper anodes; the final pumping, aging and severe testing of tubes at currents, voltages and temperatures far higher than those encountered in service conditions; and the use of Kovar Alloy*, a composition of iron, nickel, cobalt and manganese, at the point where molten glass is sealed to metal. Kovar has very nearly the same coefficient of expansion as a special glass made by Corning Glass Works. When used together the two form a seal that is not only proof against expansion flexure, but heavy and rugged as well.



"We put a fan on the CYR," says Skehan, "and the result was the Aeromax."—The first oil-immersed, shockproof, rayproof tube to be cooled by integral forced-air circulation.

MEANWHILE, Machlett Laboratories were building a very effective system to service equipment manufacturers, dealers and users, both in the field and at Springdale. At first, of course, they did it in simple prudence, as a means of making sure their tubes gave good and lengthy service. Later, they had the added incentive of gratitude to the industrial and professional friends who had helped them to so good a start. And now they were very happily impelled to continue it on a more extensive scale

*Kovar Alloy was developed by Howard Scott, an engineer of Westinghouse Electric & Manufacturing Co. Originally patented and trademarked by Westinghouse, it is now fabricated and distributed by the Stupakoff Division of The Carborundum Company.